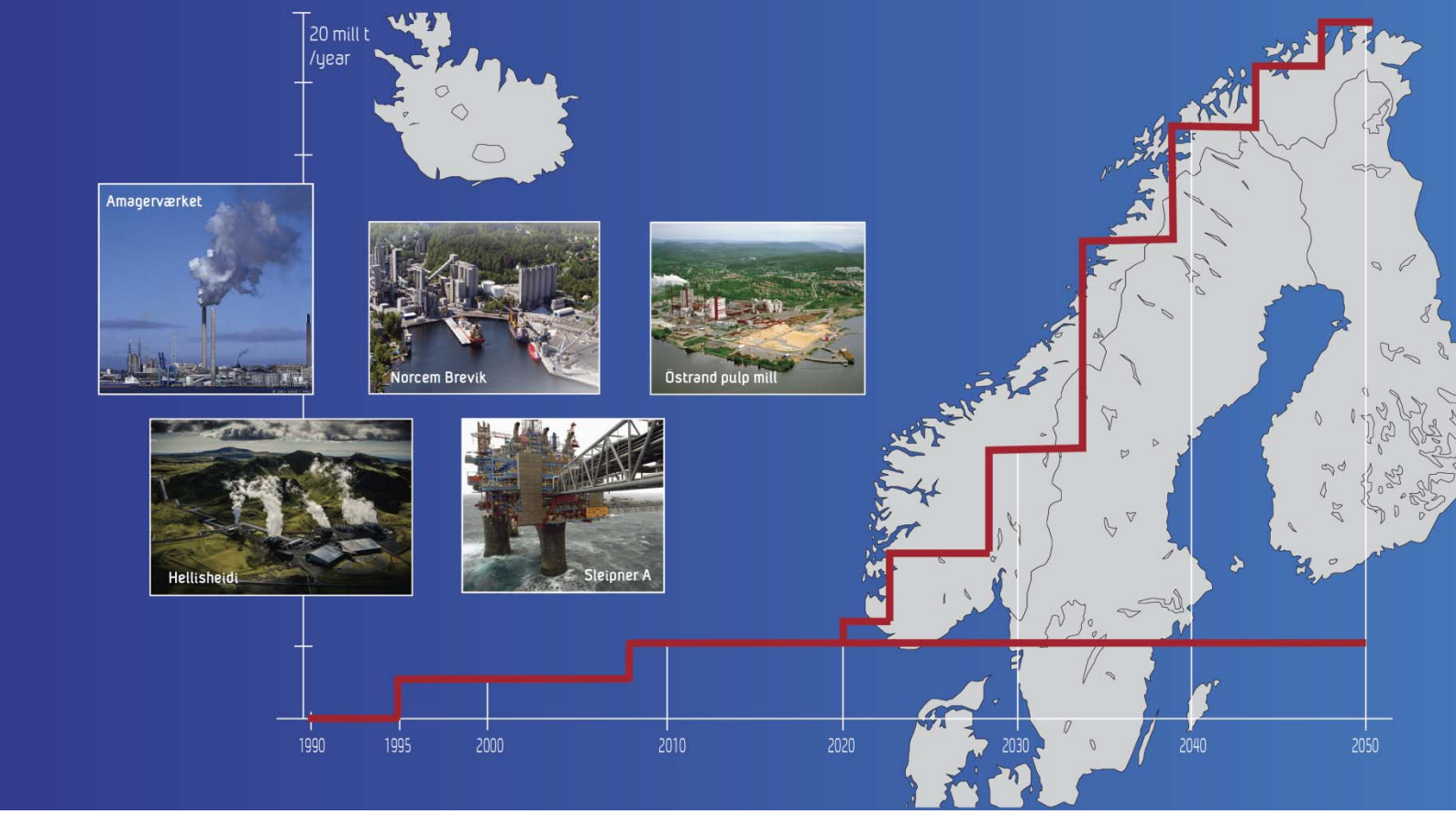

CO_2 storage modelling and capacity estimates for the Trøndelag Platform - a basin modelling approach

Ane E. Lothe, Benjamin U. Emmel & Per Bergmo

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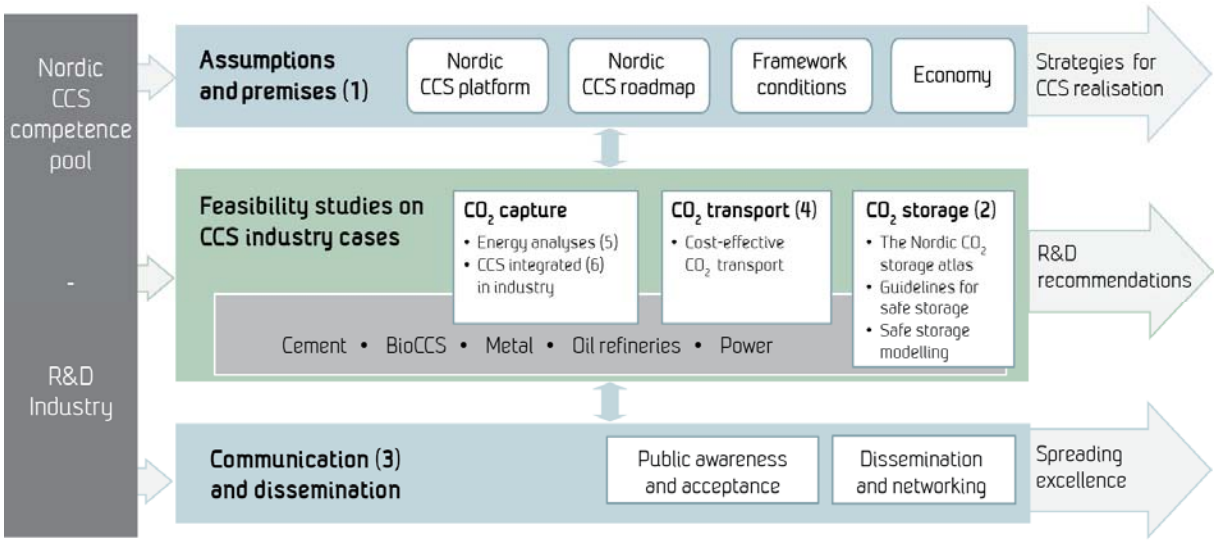

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Summary

CO_2 storage modelling and storage capacity estimates for the Trøndeslag Platform using SEMI software tool a tool readapted from exploration hydrocarbon migration modelling to reservoir modelling The SEMI software tool models migration, losses, leakage, spill and faults. It uses a ray-tracing technique to migrate CO_2 within a carrier below a sealing cap-rock.

Contribution to the International Carbon Conference, Reykjavik, Iceland, August 2014.

Keywords Modelling, storage capacity, SEMI, migration, losses, leakage, spill, faults

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About NORDICCS

Nordic CCS Competence Centre, NORDICCS, is a networking platform for increased CCS deployment in the Nordic countries. NORDICCS has 10 research partners and six industry partners, is led by SINTEF Energy Research, and is supported by Nordic Innovation through the Top-level Research Initiative.

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CO_2 storage modelling and capacity estimates for the Trøndelag Platform – a basin modelling approach

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There are several approaches to estimate possible storage capacities for aquifers and traps in sedimentary basins, ranging from static theoretical capacities estimates to more detailed methods involving dynamic modelling. Several techniques are available, from basin modelling approach – readapted from exploration hydrocarbon migration modelling to reservoir modelling – coming from oil and gas field production modelling. The SEMI software tool models migration, losses, leakage, spill and faults. It uses a ray-tracing technique to migrate CO_2 within a carrier below a sealing cap-rock [2]. This carrier unit may also act as a storage unit. The technique uses the dip of the carrier to determine pathway directions.

Figure 1 shows an example of capacity estimates using SEMI at the Trøndelag Platform area, offshore Mid-Norway. The modelling results suggest a total maximum trap-storage capacity of ca. 5.9 Gt for a non-fault scenario and significantly higher value of 21.4 Gt if sealing faults were taken into account (Figure 1). These estimates include also the eastern part of the Halten Terrace area. If we exclude the three largest traps, the storage capacity in the Trøndelag Platform will be in range of 4.9 Gt for non-fault scenario and 15.1 Gt with faults included.

The work that is carried out is part of the NORDICCS, a Nordic centre of excellence for CCS funded by the Nordic Top-level Research Initiative and industry partners.

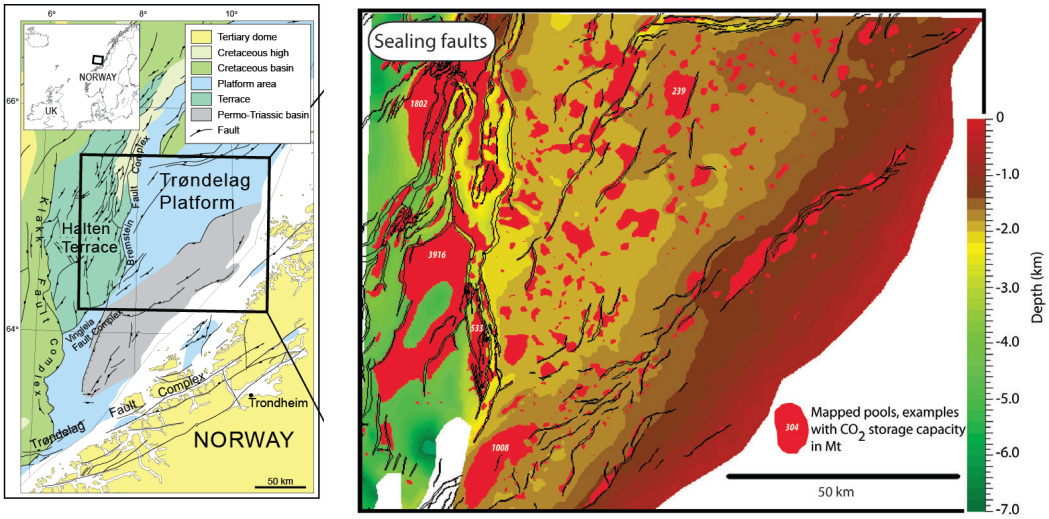


Figure 1 (Left map) Main structural elements offshore Mid-Norway, reworked from [2]. (Right map) CO_2 accumulations projected onto the top Garn Fm. depth map, SEMI modelling result.

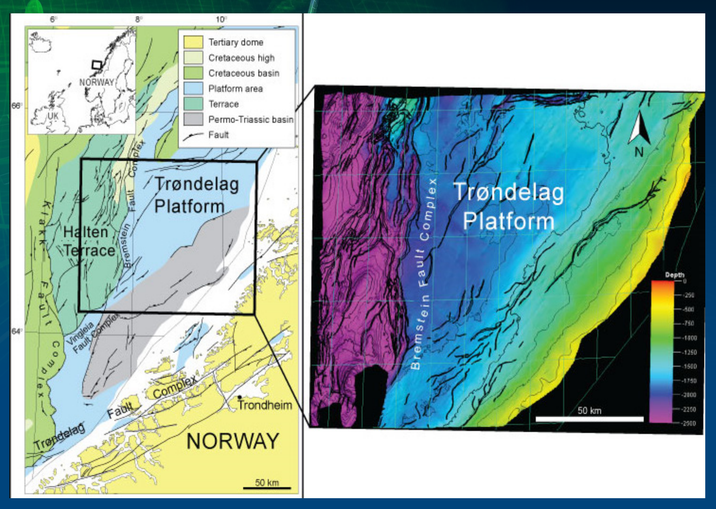
[1] Grøver et al. (2013) *Poster on the 7th Trondheim CCS Conference, 4th-5th of June 2013.*

[2] Blystad et al. (1995): *The Norwegian Sea Region. Norwegian Petroleum Directorate Bulletin*, **8**, 44 p.

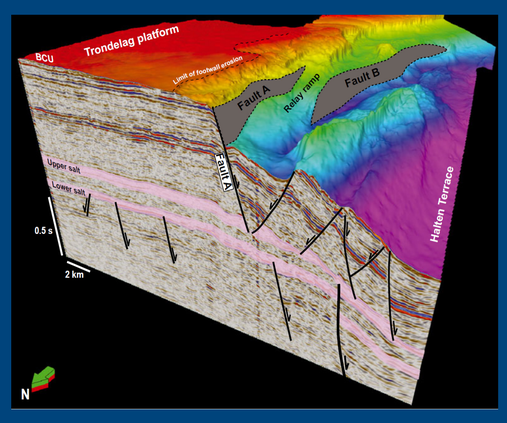
CO_2 storage modelling and capacity estimates for the Trøndelag Platform

– a basin modelling approach

There are several approaches to estimate possible storage capacities for aquifers and traps in sedimentary basins, ranging from static theoretical capacity estimates to more detailed methods involving dynamic modelling. Several techniques are available, from basin modelling approach – readapted from exploration hydrocarbon migration modelling to reservoir modelling – coming from oil and gas field production modelling.



The study area is situated offshore Mid-Norway. Left map is modified from [3]. *Right map shows depth map to top Garn Formation, with faults marked with black lines.*



The aim is to simulate CO_2 injection in the shallow Trøndelag Platform area. Example of E-W oriented seismic line from [7].

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We would like to thank the NORDICCS Nordic CCS Competence Centre for financial support. We would also like to thank SiteChar (EU project) and Statoil for use of data.

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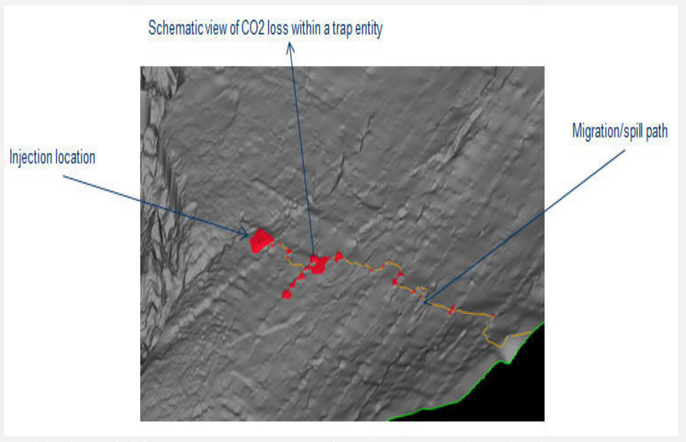
Method

The SEMI basin modelling software tool models migration, losses, leakage, spill and faults. It uses a ray-tracing technique to migrate CO_2 within a carrier below a sealing cap-rock [1,2]. This carrier unit may also act as a storage unit. The technique uses the dip of the carrier to determine pathway directions.



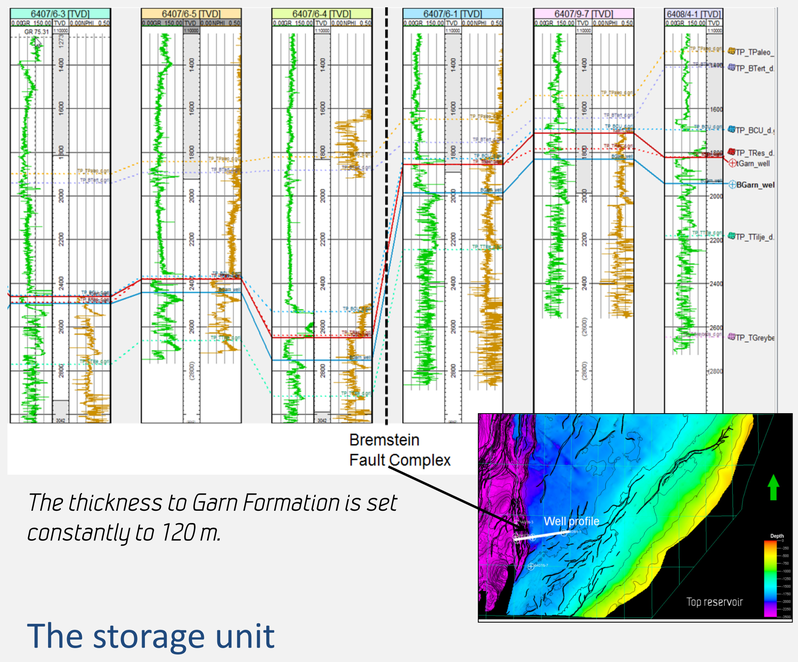
Modelled CO_2 accumulation and potential spill path after a injection period of 30 years. From [2].

Study area – geological setting

During the last two decades the Halten Terrace area, offshore mid-Norway has become a rather mature exploration area for oil and gas (www.npd.no). In the shallower Trøndelag Platform area (< 2 km), no hydrocarbons are explored and CO_2 storage on industrial scale can be a possibility [4, 5, 6].
The platform has been a large stable area since the Jurassic and it is covered by relatively flat-lying and mostly parallel-bedded strata that dips gently north-westwards.

The cap rock

The overlying low-permeable clastic rocks have a reported thickness up to 1650 m, will most likely provide an effective seal. However, they are thinning towards east and intersecting with Quaternary sections close to the Norwegian coast.



The thickness to Garn Formation is set constantly to 120 m.

The storage unit

The Middle Jurassic Garn Formation is considered as the best reservoir candidate for CO_2 storage. It is widely laterally deposited and with a sufficient thickness (see Figure). The Garn Formation consists of medium to coarse grained, moderately to well-sorted sandstones [8].

Results

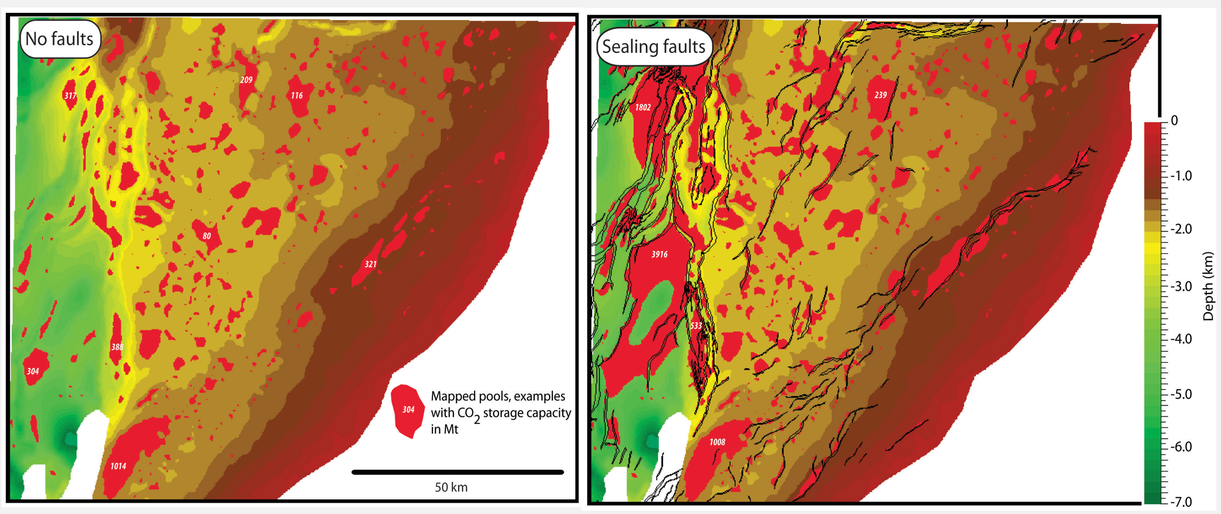
The **total trap-storage capacity** was estimated assuming the parameters given in the Table. An infinite amount of CO_2 was injected into the carrier unit and migration loss was disabled. The modelling results suggest a total maximum trap-storage capacity of ca. 5.9 Gt for a non-fault scenario and 21.4 Gt if sealing faults were taken into account. These estimates include also the eastern part of the Halten Terrace area. If we exclude the three largest traps, the storage capacity in the Trøndelag Platform will be in range of 4.9 Gt for **non-fault scenario** and 15.1 Gt with **faults included**.

Input parameter used in the modelling

Stratigraphy	Middle Jurassic Garn Fm
Lithology	Sandstone
Thickness	120 m
Thermal gradient	35 degrees/km
Porosity	Calibrated vs. measured data [9]
Pressure	Hydrostatic
Water depth	Present day seabed
Entry pressure	5000 Pa
Total injection	Variable
CO2 diss-rate factor	100 000
Storage efficiency	100 %

Conclusions

Basin modelling approach can be used for storage capacity estimates. This example demonstrates that taking the effect of sealing faults into account will have a large effect on the amount of storage capacities.



CO_2 accumulations projected onto the Garn Formation depth map a) without faults and b) with faults included. In order to estimate a total trap-storage capacity for the Garn Formation the whole area was "flooded" with CO_2 and all traps were filled to a maximum.

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